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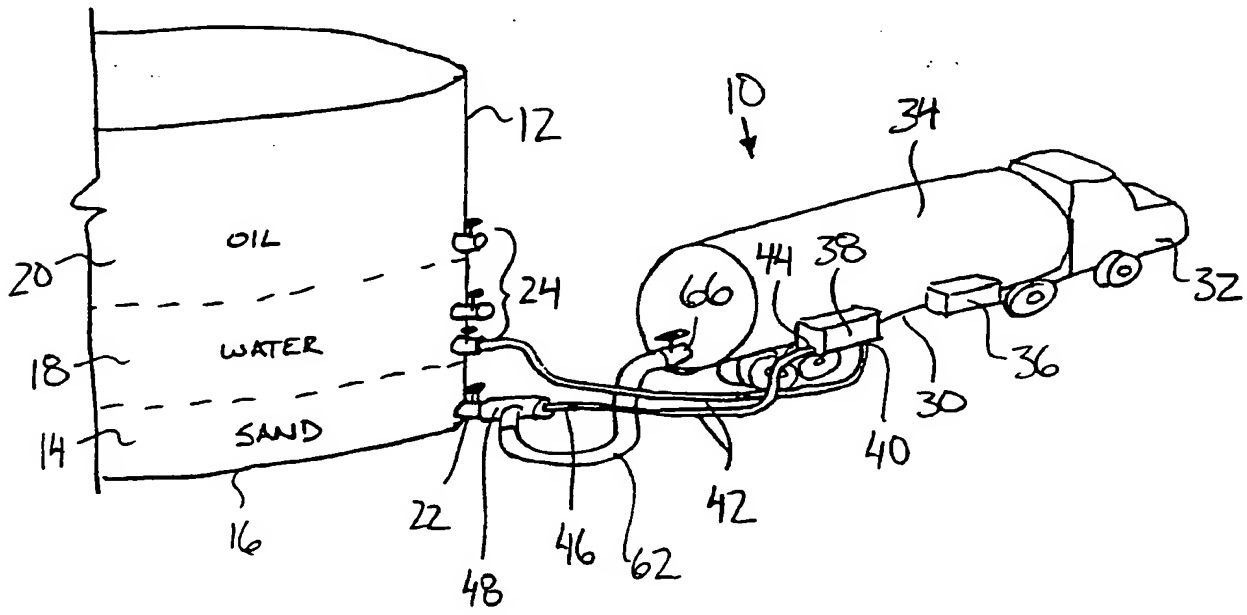

(57) Abrégé/Abstract:
A method and apparatus are provided for cleaning an oil storage tank. The apparatus includes a portable vacuum collection tank and a recirculating pump. The pump is coupled at an inlet to a layer of produced water in the storage tank and at an outlet to an injector at a bottom of the tank for stirring up settled sand. A suction line removes the stirred up sand into the vacuum collection tank. The portable tank and recirculating pump can be supported on a single vehicle for transport from site to site while the use of produced water as a fluidising agent in a storage tank cleaning operation eliminates a second pressure truck having a supply of fluidising agent being required as in conventional cleaning operations.

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ABSTRACT

A method and apparatus are provided for cleaning an oil storage tank. The apparatus includes a portable vacuum collection tank and a recirculating pump. The pump is coupled at an inlet to a layer of produced water in the storage tank and at an outlet to an injector at a bottom of the tank for stirring up settled sand. A suction line removes the stirred up sand into the vacuum collection tank. The portable tank and recirculating pump can be supported on a single vehicle for transport from site to site while the use of produced water as a fluidising agent in a storage tank cleaning operation eliminates a second pressure truck having a supply of fluidising agent being required as in conventional cleaning operations.

METHOD AND APPARATUS FOR CLEANING OIL STORAGE TANKS

FIELD OF THE INVENTION

The present invention relates to a method of cleaning a crude oil storage tank and more particularly to the apparatus used for cleaning the oil storage tank.

BACKGROUND

When storing crude oil in an oil storage tank the oil is known to be separated into layers including a layer of settled sand at a bottom of the tank, an intermediate layer of produced water from the crude oil, and an upper layer of separated oil. The sand which settles on the bottom of the tank forms deposits, the removal of which require periodic cleaning of the tank. It is also desirable for some of the produced water in the tank to be removed in conventional cleaning operations. Various devices have been designed specifically for cleaning oil storage tanks. Examples of these are found in the following Untied States patents: 6,142,160 to Winslow et al, 6,125,865 to Bacon Cochrane et al, 5,582,652 to Robertson et al, 5,561,883 to Landry et al, 5,421,903 to Manabe et al, 5,293,887 to Thibodeaux, 4,859,323 to Rolfvondenbaumen and 4,770,711 to Deal, III et al. None of these devices however are particularly suited for being readily transported from site to site in an efficient and low cost manner.

SUMMARY

According to one aspect of the present invention there is provided an apparatus for cleaning an oil storage tank, the apparatus comprising:

a portable collection tank;

an injector nozzle for injecting fluid into the oil storage tank adjacent a bottom of the oil storage tank;

a pump having an inlet for receiving produced water from the oil storage tank and an outlet for communication with the injector; and

a suction line for connection between the bottom of the oil storage tank and the collection tank.

The portable tank and recirculating pump can be supported on a single vehicle for transport from site to site while enabling the use of produced water as a fluidising agent in a storage tank cleaning operation. This eliminates the requirement of a second pressure truck having a supply of fluidising agent as in conventional cleaning operations.

The collection tank and pump are preferably supported on a single vehicle such as a trailer unit which can be used on site.

The pump of the apparatus may be operable within a range of output pressures between 40 and 250 psi, however an ideal output pressure is between 60 and 80 psi.

The pump inlet is preferably arranged to be coupled to a standard valve on storage tank spaced above a floor of the storage tank.

The pump may comprise a gear pump or in alternate arrangements, a progressive cavity pump.

In the preferred embodiment, the collection tank comprises a vacuum tank.

According to a second aspect of the present invention there is provided a method of cleaning an oil storage tank comprising:

providing a portable collection tank;

providing an injector nozzle for injecting fluid into the oil storage tank;

providing a recirculating pump

coupling an inlet of the recirculating pump to the oil storage tank;

coupling an outlet of the recirculating pump for communication with the injector;

providing a suction line;

connecting the suction line in communication between the bottom of the oil storage tank and the collection tank;

locating the injector nozzle adjacent a bottom of the oil storage tank;

operating the recirculating pump to draw produced water from the oil storage tank and to inject the produced water back into the oil storage tank through the injector nozzle;

operating the suction line to draw a slurry from the bottom of the oil storage tank into the collection tank.

The method preferably includes coupling the inlet of the recirculating pump to a lowermost standard valve on the storage tank at a location spaced above the floor of the storage tank in alignment with a layer of produced water in the storage tank.

Operation of the recirculating pump may cease when a level of produced water in the storage tank falls below the standard valve on the storage tank, when sufficient sand has been removed from the storage tank or when the collection tank is full.

An external water supply may be provided when there is insufficient produced water in the storage tank.

The method preferably includes allowing the slurry in the collection tank to settle and pumping the produced water from which the sand in the slurry has settled back into the storage tank.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, which illustrate an exemplary

embodiment of the present invention:

Figure 1 is an isometric view of the apparatus shown coupled to a crude oil storage tank.

Figure 2 is a schematic view of the apparatus according to Figure 1 as shown coupled to a crude oil storage tank.

Figure 3 is a partly sectional view of the manifold coupling the suction line and the injector of the apparatus of Figure 1 to the bottom valve of a storage tank.

DETAILED DESCRIPTION

Referring to the accompanying drawings, there is illustrated a tank cleaning apparatus generally indicated by reference numeral 10. The apparatus 10 is generally arranged for cleaning crude oil storage tanks 12 for storing crude oil therein.

When the crude oil is permitted to separate, various layers are formed within the tank including a layer of oil sands 14 at a bottom 16 of the tank, an intermediate layer of produced water 18 and an upper layer of separated oil 20 above the produced water. Typical storage tanks 12 include a bottom valve 22 located in a side wall of the tank adjacent the floor thereof for communication with the sand 14 in the tank. One or more intermediate valves 24 are also provided in the side wall of the tank at various positions spaced above the floor of the tank. A common reference height of typical intermediate valves is 3 feet from the floor of the tank for communication with the produced water 18 in the tank, however various other intermediate valves may be located at 4, 5 or 7 feet as examples.

The apparatus 10 is arranged to be supported on a trailer 30 so that the apparatus is portable from site to site when towed by a suitable truck 32 for on sight use of the apparatus. The trailer 30 includes a conventional collection tank 34

supported thereon which is suitably sealed for permitting a vacuum pressure to be contained therein. A vacuum pump 36 is supported on the trailer 30 in communication with the collection tank 34 adjacent a top end of the tank for creating the vacuum pressure within the tank as in conventional vacuum tank trailers.

The apparatus 10 also includes a recirculating pump 38 which is arranged to be supported on the trailer 30 along side one of the fenders of the trailer or adjacent a cab of the truck 32. The recirculating pump 38 is a gear pump having an inlet which is arranged to be connected to one of the intermediate valves 24 of the storage tank 12 by suitable flexible hoses 42. The inlet 40 of the recirculating pump can be connected to an external supply of fluidizing agent, however in the illustrated embodiment the inlet 40 is arranged to draw produced water 18 from the storage tank 12 for recirculation back into the storage tank 12 adjacent the bottom end thereof through bottom valve 22. This is accomplished by connecting the outlet 44 of the recirculating pump 38 to a rigid injector wand 46 by suitable flexible hoses 42.

A manifold 48 is provided for coupling the injector wand 46 to the bottom valve 22 of the storage tank. The manifold 48 generally comprises an outer pipe 50 which couples a T-shaped fitting 52 thereon such that a main portion of the T-shaped fitting extends generally radially outwardly from a side wall of the storage tank 12. The injector wand 46 is substantially smaller in diameter than an inner diameter of the outer pipe 50 and the T-shaped fitting 52 so as to permit the injector wand 46 to be slidably displaced concentrically therein while being spaced from the walls of the pipe. An outer end 54 of the main portion of the T-shaped fitting 52 includes a seal mounted between the injector wand 46 and the fitting 52 for sealing therebetween while permitting the injector wand 46 to remain slidable relative to the T-shaped fitting.

The injector wand is an elongate rigid pipe in the order of 18 feet in length which is arranged to be extended into the storage tank 12 through the bottom valve 22 by the manifold 48 so that a free end 56 of the injector wand 46 is movable across a bottom of the storage tank 12. The outer end 58 of the injector wand 46 is coupled by the flexible hose 42 to the pump 38 such that produced water from the storage tank is pumped through the wand and into the sands 14 at a bottom of the tank by suitable nozzles 60 supported on the wand 46. The nozzles 60 may be positioned at various directions for injecting the produced water into the sands 14 so that the sands may be stirred up and removed from the tank. The nozzles 60 are located adjacent the free end of the wand 46 so as not to interfere with sliding movement of the wand through the manifold 48.

A branched portion of the T-shaped fitting 52 is coupled to a suction line 62 which connects the manifold 48 to the collection tank 34 at a location within the tank spaced below a top end of the collection tank. The suction line 62 is a suitable flexible hose arranged to pump a slurry of produced water and sand 14 therethrough. The slurry is drawn through the suction line 62 and into the collection tank 34 due to vacuum pressure in the collection tank as maintained by the vacuum pump 36. The slurry is drawn into the suction line 62 through the bottom valve 22 in the side wall of the tank in the annular space defined between the injector wand 46 and the surrounding outer pipe 50 of the manifold 48.

The apparatus 10 is thus arranged to support all equipment required for cleaning sand from a crude oil storage tank on a single trailer or vehicle. Because produced water from the storage tank itself is used for stirring up the sands an extra pressure truck having its own supply of fluidizing agent is not required. The use of a recirculating pump supported directly on the same trailer as the collection tank 34 is sufficient for stirring up the sands in the storage tank even when operated

at low pressures. The apparatus 10 and the recirculating pump thereof, remain effective when operated in a range of 40 to 250 psi however an ideal range appears to be in the range of 60 to 80 psi at an outlet of the recirculating pump 38. The flexible hoses 42 which are arranged to maintain pressure therein can easily handle this range of pressure which is considerably safer than pressures in the order of 2000 psi which are known to be used with the plunger pumps of pressure trucks normally required for oil storage tank cleaning operations.

In order to use the apparatus 10 the various flexible hoses 42 must be connected between the recirculating pump 38, the collection tank 34 and the oil storage tank 12. This includes connecting the suction line 62 between the manifold 48 at the bottom valve 22 and the collection tank 34. An inlet flexible hose 42 is connected between the inlet 40 of the recirculating pump 38 and a selected intermediate valve 24 of the storage tank 12 which is in alignment with a level of produced water 18 within the tank. An outlet flexible hose 42 is then coupled between the outlet 44 of the recirculating pump 38 and the outer end of the injector wand 46 which is positioned in a sealing configuration within the manifold 48 to extend into the storage tank 12.

The cleaning operation begins by operating the vacuum pump 36 to maintain a vacuum pressure within the collection tank 34. A valve 66 coupled between the suction line 62 and the collection tank 34 is then opened so that the suction line 62 is exposed to the vacuum pressure of the collection tank 34. Opening the intermediate valve 24 to which the inlet flexible hose 42 is coupled then permits produced water to be introduced to the inlet of the recirculating pump 38 which is then put into operation for dispensing pressurized produced water through the injector wand 46. Opening the bottom valve 22 to which the manifold 48 is connected permits the injector wand 46 to be introduced into the storage tank 12 so

that the pressurized produced water from the recirculating pump 38 is injected into the sands 14 across a bottom of the storage tank. Displacement of the free end of the injector wand 46 back and forth across the tank stirs the sand 14 at the bottom of the tank into a slurry which is then sucked into the suction line 62 via the space between the injector wand and the outer walls of the manifold 48 at the bottom valve 22. The slurry is drawn through the suction line 62 into the collection tank 34 to remove the sands from the oil storage tank 12. The operation ceases by discontinuing operation of the pumps and disconnecting all of the flexible hoses once the appropriate valves have been closed. The cleaning operation terminates when the collection tank 34 has been filled to a desired amount of sand in a slurry of produced water. The slurry is then permitted to settle within the collection tank 34 so that the water in the collection tank from which the sand has settled out of can be pumped back into the oil storage tank for later use in a further cleaning operation. The water may be pumped back by reconnecting the inlet of the recirculating pump 38 to the collection tank 34 at an intermediate location above the settled sand in the tank. In an alternate arrangement the water in the collection tank 34 can be returned to the storage tank by pressurising the collection tank with the suction line 62 being connected at one end to the valve 66 on the collection tank above the level of settled sand spaced above a bottom end of the tank and at the other end to the intermediate valve 24 on the storage tank. Opening valves 66 and 24 with the collection tank 34 being pressurised thus forces the water back into the storage tank. More sand can then be removed from the oil storage tank 12 by reconnecting the inlet of the recirculating pump 38 to a suitable intermediate valve 24 of the oil storage tank in alignment with produced water within the tank or by reconnecting the suction line 62 as described above. The vacuum pump 36 can again be operated with the cleaning operation steps being repeated so that a further slurry of sand and

produced water is introduced into the collection tank 34. If more sand is desired to be removed from the oil storage tank 12 various cycles of permitting sand to settle within the collection tank 34 for reuse of the produced water can be performed, however if it is desirable to remove both the sand 14 and a portion of the produced water 18 from the storage tank 12 the apparatus 10 may cease the cleaning operation and hall away the water and sand at any moment.

In this arrangement only a single unit is required for cleaning an oil storage tank as opposed to a collection vehicle and a pressure vehicle for supplying a fluidizing agent as is required in conventional cleaning operations. In this arrangement no water or oil is transferred to or from the collection tank 34 other than washed sand 14 and a portion of the produced water 18 which carries the sand into the tank in a slurry. The recycled use of produced water using a recirculating pump 38 as described also permits operation under much lower pressures than conventional cleaning operations for reducing occurrences of injury and costly damage due to accidental hose rupturing and the like.

When using the cleaning operation as described herein for the first time in some instances, there may be insufficient produced water within the storage tank 12. In this instance some water may initially be added to the storage tank 12 prior to cleaning, however if the produced water and sand slurry removed from the storage tank 12 are permitted to settle in the collection tank 34 with the produced water being returned to the storage tank 12, further water is typically not required to be added in further cleaning operations. Furthermore additional produced water results when it is separated from crude oil added to the storage tank 12 and separated therein.

In further embodiments of the present invention, other forms of trailers may be suitable without using a vacuum collection tank 34. Any suitable

container may be used when suitable pumps are provided in communication with the suction line 62 for pumping the slurry from the bottom valve 22 of the storage tank 12 to the container on the alternate trailer. A vacuum collection tank 34 on a trailer 30 as described herein however is preferred as the vacuum pump 36 generally has a longer life than slurry pumps and is able to provide constant suction to the suction line 62.

In other embodiments the recirculating pump 38 may comprise a progressive cavity pump for example in place of a gear pump as described above. A gear pump is generally preferred as it is cheaper and lighter so as to permit the pump to be readily supported on the trailer 30. While the gear pump may not be able to handle as much debris being pumped therethrough as a progressive cavity pump, progressive cavity pumps are considerably more expensive.

While one embodiment of the present invention has been described in the foregoing, it is to be understood that other embodiments are possible within the scope of the invention. The invention is to be considered limited solely by the scope of the appended claims.

CLAIMS:

1. An apparatus for cleaning an oil storage tank, the apparatus comprising:

a portable collection tank;

an injector nozzle for injecting fluid into the oil storage tank adjacent a bottom of the oil storage tank;

a pump having an inlet for receiving produced water from the oil storage tank and an outlet for communication with the injector; and

a suction line for connection between the bottom of the oil storage tank and the collection tank.

2. The apparatus according to Claim 1 wherein the collection tank and pump are supported on a single vehicle.

3. The apparatus according to Claim 1 wherein the pump is operable within a range of output pressures between 40 and 250 psi.

4. The apparatus according to Claim 1 wherein the pump inlet is arranged to be coupled to a standard valve on storage tank spaced above a floor of the storage tank.

5. The apparatus according to Claim 1 wherein the pump comprises a gear pump.

6. The apparatus according to Claim 1 wherein the pump comprises a progressive cavity pump.

7. The apparatus according to Claim 1 wherein the collection tank comprises a vacuum tank.

8. A method of cleaning an oil storage tank comprising:

providing a portable collection tank;

providing an injector nozzle for injecting fluid into the oil storage tank;

providing a recirculating pump

coupling an inlet of the recirculating pump to the oil storage tank;

coupling an outlet of the recirculating pump for communication with the injector;

providing a suction line;

connecting the suction line in communication between the bottom of the oil storage tank and the collection tank;

locating the injector nozzle adjacent a bottom of the oil storage tank;

operating the recirculating pump to draw produced water from the oil storage tank and to inject the produced water back into the oil storage tank through the injector nozzle;

operating the suction line to draw a slurry from the bottom of the oil storage tank into the collection tank.

9. The method according to Claim 8 including supporting the collection tank and the recirculating pump on a single vehicle.

10. The method according to Claim 8 including operating the recirculating pump within a range of outlet pressures between 40 and 250 psi.

11. The method according to Claim 8 including coupling the inlet of the recirculating pump to a standard valve on the storage tank at a location spaced above the floor of the storage tank in alignment with a layer of produced water in the storage tank.

12. The method according to Claim 11 including ceasing operation of the recirculating pump when a level of produced water in the storage tank falls below the standard valve on the storage tank.

13. The method according to Claim 11 including coupling the inlet of the recirculating pump to a lowermost standard valve on the storage tank in

alignment with the layer of produced water in the storage tank.

14. The method according to Claim 8 wherein the recirculating pump comprises a gear pump.

15. The method according to Claim 8 wherein the recirculating pump comprises a progressive cavity pump.

16. The method according to Claim 8 wherein the collection tank comprises a vacuum tank.

17. The method according to Claim 8 including providing an external water supply when there is insufficient produced water in the storage tank.

18. The method according to Claim 8 including allowing the slurry in the collection tank to settle and pumping the produced water from which the sand in the slurry has settled back into the storage tank.

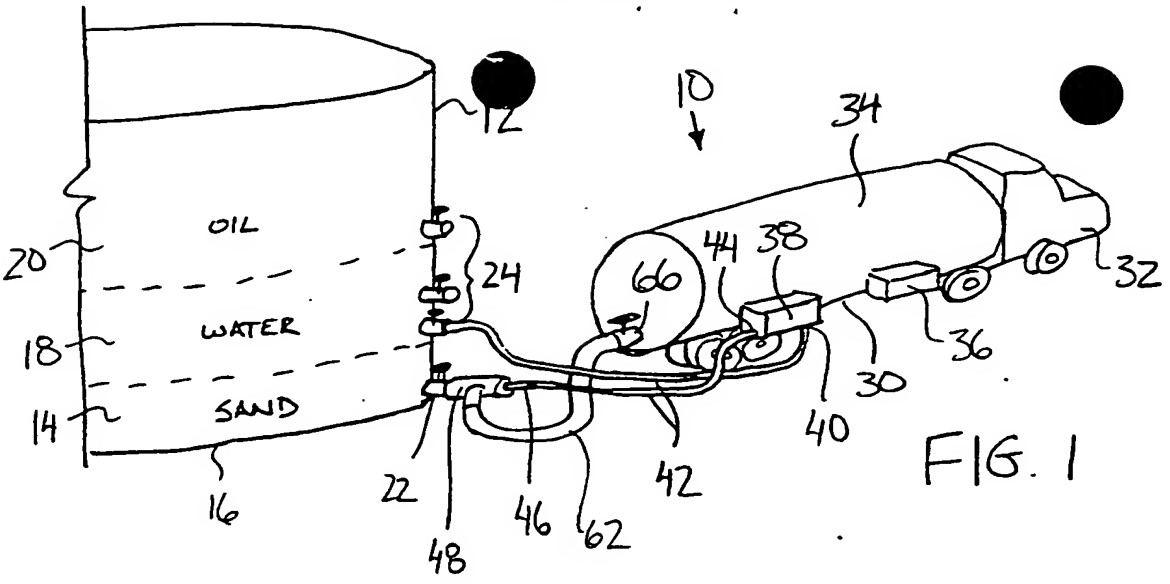

FIG. 1

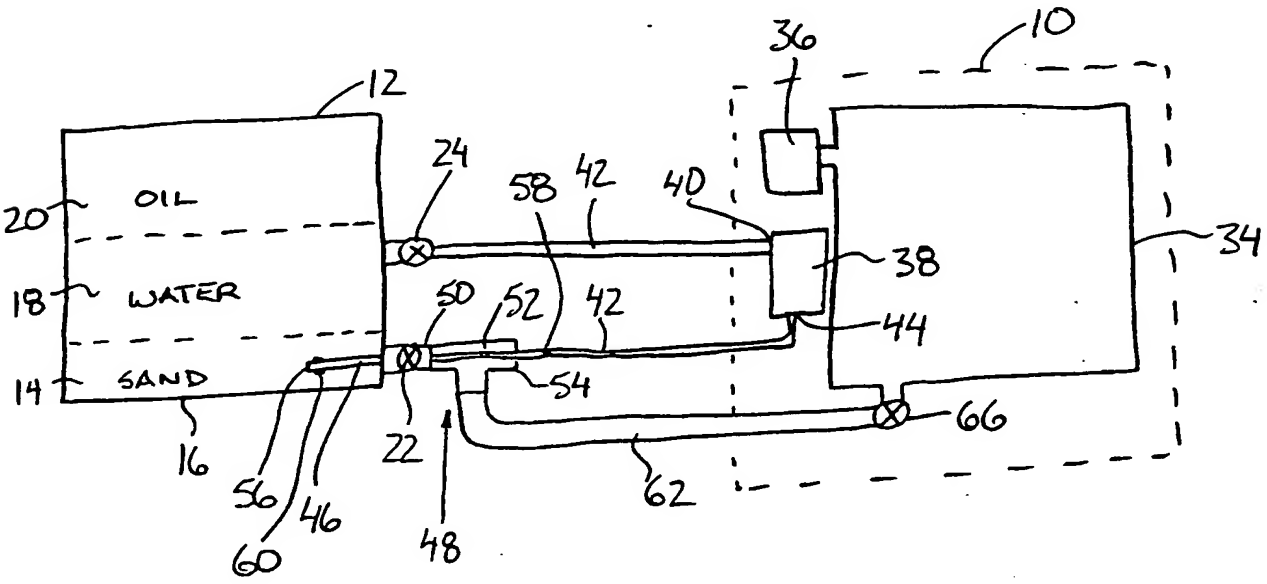

FIG. 2

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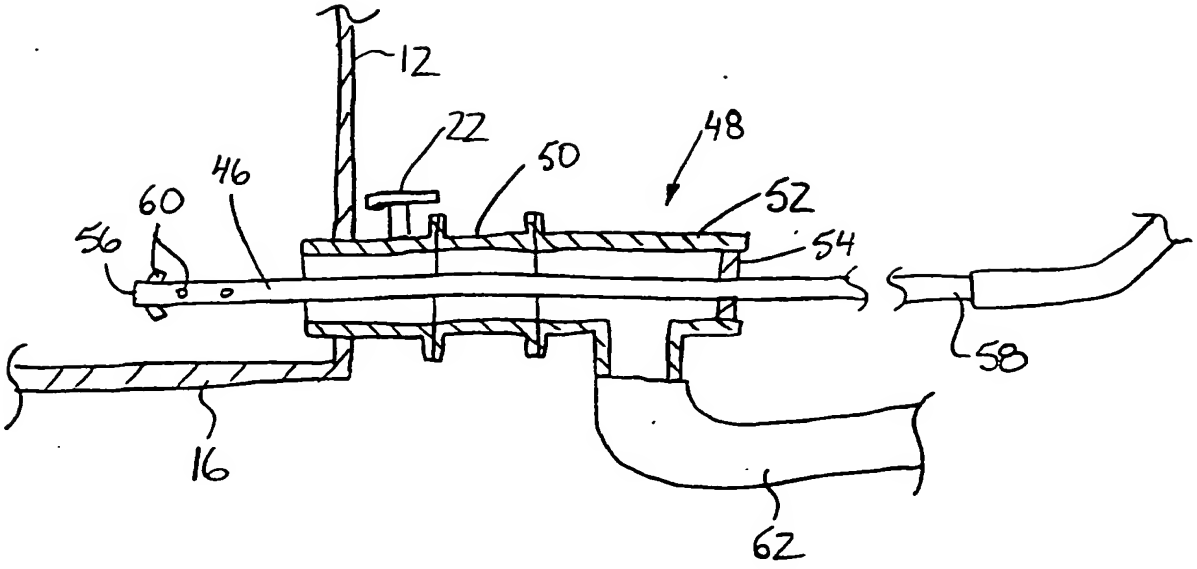

FIG. 3

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